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Planting Distance Effects on Mango-sweet Gourd Agroforestry System in the Mymensingh District of Bangladesh

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Authors' contributions

This work was carried out in collaboration between all authors. Author IR performed the field experiments and statistical analysis. Author MAW designed the study. Author MMR wrote the protocol and the first draft of the manuscript. Authors MRZ and MLA managed the literature searches. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Aims: To evaluate the growth performance of sweet gourd (*Cucurbita moschata*) under 3.5 years old Mango (*Mangifera indicia* L.) tree at planting different distances.
Study Design: The experiment was laid out following the Randomized Complete Block Design (RCBD) arrangement with three replications.
Place and Duration of Study: The experiment was conducted at the Kalibari char which is situated by the side of Brahmaputra River adjacent to the Bangladesh Agricultural University, Mymensingh, during the period of November 2013 to March 2014.
Methodology: The experiment consisted of five different treatments viz. T_0 (sole sweet gourd and sole mango trees), T_1 (Sweet gourd grown 0- 0.5 m distance from the tree), T_2 (Sweet gourd grown

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0.5- 1.0 m distance from the tree), T_3 (Sweet gourd grown 1.0-1.5 m distance from the tree) and T_4 (Sweet gourd grown >1.5 m distance from the tree) and ten mango tree yield.

Results: The result showed that different morphological characteristics of sweet gourd were increased gradually with increasing distance from the tree base. The highest yield of sweet gourd was 25.8 t/ha obtained from treatment T_0 (Sole sweet gourd). Among the different distances, the highest yield of sweet gourd was 23.7 t/ha in T_4 (>1.5 m distances from the tree base) and the lowest was 16.2 t/ha in T_1 (0-0.5 m distances from the tree base). On the other hand the best fruit yield of mango (8.6 t/ ha) was recorded in without sweet gourd association. In association with sweet gourd the fruit yield of mango was recorded (5.9 t/ha).

Conclusion: The yield of sweet gourd as a vegetable under sole cropping condition gives the best result in association with mango trees, the further the distance from the tree, the higher the yield of sweet gourd.

Keywords: Mango; sweet gourd; char land; agroforestry system.

1. INTRODUCTION

Agroforestry is an integrated approach of using the interactive benefits from combining trees and shrubs with crops and/or livestock. It combines agricultural and forestry technologies to create more diverse, productive, profitable, healthy, and sustainable land-use systems.

Bangladesh is one of the densely populated countries of the world having a population of 152.25 million in the area of 147570 sq. kilometers and growth rate of 1.37% per annum [1]. So, the need for maintaining the balance between the population and nutrition can hardly be overemphasized. Most of the people of our country suffer from malnutrition especially vitamins and minerals. Mango and sweet gourd are a good source of readily available vitamin and minerals. They are also very cheap and easily available. They are quite hardy, prolific bearer and highly remunerative even without much cares [2]. This vegetable and fruits can be grown in homestead areas (the homestead area per household of Bangladesh is 0.28 ha) throughout the country even with little to no care.

In Bangladesh, a large number of vegetables are grown of which most of them are grown in winter season. Financial returns from vegetables showed that winter vegetables production is more profitable than the production of most field crops [3]. Among the winter vegetables, sweet gourd is an important vegetable in Bangladesh. Sweet gourd is important for its quick growing nature and high yielding potential. It is easily cultivated as a companion crop or inter crop. It is a well-known and a very popular vegetable grown successfully throughout the Bangladesh. Sweet gourd or pumpkin is a tender tendril bearing and vine like plant from genus Cucurbita belonging to the family Cucurbitaceae of gourd family. There are three common types of pumpkin worldwide, namely *Curcurbita pepo, Curcurbita maxima* and *Curcurbita moschata* and were originally domesticated in Mexico, South America, and the eastern United State of America [4].

Mango (*Mangifera indicia* L.) belonging to the family Anacardiaceae, is one of the most important and popular fruits of Bangladesh. The acreages and production of mango during the 2000- 2001 were 152125 acres and 293570 tons respectively [5]. It is being cultivated in this subcontinent since 4000 years ago [6]. Mango ranks third among the tropical fruits grown in the world with the total production of 45563 thousand metric tons [7]. For identifying the compatible tree-crop combination, i.e. different crops should be screened out in terms of their adaptabilty and yield in association with fruit tree. For this purpose, the best way of evaluating is to grow different crop4s at different spacing from the tree base. So, if we know the suitability of different crops in terms of growth and yield, it would be very useful information for selecting the best tree-crop combination. Therefore, the current study was undertaken to examine the effect of tree–crop arrangements at varying distances on crop growth and yield performance.

2. MATERIALS AND METHODS

2.1 Experimental Site Description

The experiment was carried out on the experimental farm at Char Kalibari, Mymensingh, Department of Agroforestry, Bangladesh Agricultural University, Mymensingh. The geographical position of char kalibari is 24℃45' - 24℃45'40'' North and 90℃24'4''- 90℃24'44'' East. The soil has pH value between 6.5 and 6.8.

2.2 Experimental Design and Crop Husbandry

The experiment was laid out following the Randomized Complete Block Design (RCBD) arrangement with three replications. Different treatments of this study are as follows: T_0 (Sole sweet gourd and sole mango trees), T_1 (Sweet gourd grown 0- 0.5 m distance from the tree), T_2 (Sweet gourd grown 0.5- 1.0 m distance from the tree), T_3 (Sweet gourd grown 1.0-1.5 m distance from the tree), T_4 (Sweet gourd grown >1.5 m distance from the tree) and ten mango tree yield. The plot size was 3mx3m. Well decomposed cow dung at the rate of 8 ton/ha were applied in the field. No chemical fertilizer was applied. Emergence of sweet gourd seedling started after 15 days from the date of sowing. Seedlings were thinned out 3/hill to maintain the optimum number of population. No pesticide and fungicide were used in the field for tree-vegetable production. It was kept weed free by weeding. Sweet gourd was harvested at 90 days after seed sowing.

2.3 Data Collection

2.3.1 Sweet gourd

Five plant samples were collected randomly from all treatments of the plots for data collection. Data were collected at vegetative stages (20 days after planting and 40 days after planting) and harvesting stage. The following plant characters of sweet gourd were recorded such as vine length (cm), no of primary branch plant^{-1}, no of leaves branch^{-1}, no. of leaves plant^{-1}, length of leaf petiole (cm), leaf length (cm), leaf breadth (cm), no. of fruits plant^{-1}, single fruit weight (g), yield of sweet gourd (t/ha) and yield of sweet gourd (kg/plant) at each harvest time.

2.3.2 Mango

Ten tree samples were collected randomly from all treatments of the plots for data collection. Data were collected at fruiting stage. The growth characteristics of mango such as, no of branch plant^{-1}, average no of fruit branch^{-1}, no of fruit plant^{-1}, average fruit length, average fruit diameter & average fruit weight (g) were recorded at each harvest time.

2.4 Data Analysis

The analysis of variance for each of the measured character was done by F (variance ratio) test following Randomized Complete Block Design by using PC MA-STAT software and wasp2 software package to find out the statistical significance of the experimental results. The mean differences were evaluated by Duncan's New Multiple Range Test (DMRT) [8].

3. RESULTS AND DISCUSSION

3.1 Morphological Characteristics of Sweet Gourd at Harvesting Stage

3.1.1 Vine length (cm)

The vine length of sweet gourd was varied significantly when grown under mango tree (Table 1). Among the different distances the highest vine length of sweet gourd was found 310.3 cm in T_4 (>1.5 m distance from the tree) which was statistically similar to its T_0 treatment. The lowest was 170.5 cm found in T_1 (0.0-0.5 m from the tree). The vine length of sweet gourd was increased consistently with the increase of distance from tree base which was supported by [9,10,11,12] in sweet gourd.

Table 1. Morphological characteristics of sweet gourd at harvesting stage by treatment

Treatment	Vine length (cm)	No. of primary branches/plant	No. of leaves/ primary branches	No. of fruit /plant	Fruit weight (g)
T_0	304.5	10.7	17.5	12.5	1975.5
T_1	170.5	6.0	10.4	6.0	1180.0
T_2	240.3	8.0	13.0	8.5	1450.0
T_3	290.5	10.7	16.7	11.5	1950.0
T_4	310.3	11.5	18.0	12.0	2000.0
CV (%)	0.060	4.030	2.000	2.714	1.221
Lsd (0.01)	0.431	1.035	0.836	0.752	57.420
Level of significance	**	**	**	**	**

Note: Means in column followed significantly different by DMRT at $p \leq 0.01$, T0=Control, T_1 = 0.5 m distance from the tree, T_2=0.5- 1.0 m distance from the tree, T_3 =1.0-1.5 m distance from the tree and T_4= >1.5 m distance from the tree

3.1.2 Number of primary branches plant^{-1}

The results shows that there were significant variation in no. of primary branches plant^{-1} of sweet gourd grown under mango tree. Table 1 indicates that the highest no. of primary branches plant^{-1} (11.5) was produced by T_4 (>1.5 m distance from the tree). The second highest no. of primary branches plant^{-1} (10.7) was produced under T_3 (1.0-1.5 m distance from the tree) which was statistically similar to its T_0 while the lowest (6.0) was observed in T_1 (0.0-0.5 m distance from the tree). Sayed [9] observed that sweet gourd grown in the absence of shading and distance from the tree base gave the best results. Similar results were also found by [10,11].

3.1.3 Number of leaves primary branches^{-1}

There were significant variations at 1% level of probability in no. of leaves branch^{-1} of sweet gourd grown under mango tree (Table 1). The results showed that the highest no. of leaves branch^{-1} (18.0) was recorded in T_4 (>1.5 m distance from the tree) and the lowest (10.4) was recorded at T_1 (0.0-0.5 m distance from the tree). T_0 and T_4 were statistically similar. The second highest no. of leaves branch^{-1} (16.7) was produced under T_3 (1.0-1.5 m distance from the tree). T_4 and Control produces the best result due to the absence of shading effect as previously observed by several authors [9,10,11,12].

3.1.4 Number of fruits plant^{-1}

The result indicates that no. of fruit plant^{-1} significantly influenced the performance of sweet gourd grown under mango tree (Table 1). The highest number of fruits plant^{-1} (12.5) was observed at T_0 (open field referred as control) and the lowest (6.0) number of fruits plant^{-1} was found under close contact of the tree referred as T_1 (0.0-0.5 m distance from the tree). The number of fruits plant^{-1}of sweet gourd decreased by increasing shade level as noted also by others [9,10,11,12].

3.1.5 Fruit weight (g)

There were significant variations at 1% level of probability in fruit weight of sweet gourd grown under mango tree (Table 1). The result indicates that the highest fruit weight (2000.0 g) was recorded at T_4 (>1.5 m distance from the tree) which was statistically similar to the treatment referred to as control. Due to high competition between tree and crop the lowest fruit weight (1180.0 g) was found in T_1 (0.0-0.5 m distance from tree) and second highest fruit weight (1950.0 g) was found at T_3 (1.0-1.5 m distance from the tree).Fruit weight of sweet gourd decreased by increasing shade level and that has also been reported by Reddy [13].

3.1.6 Yield of sweet gourd (t/ha)

There were significant variation in sweet gourd yield per hectare due to different treatments grown under mango tree. As evident from the results, the highest yield of sweet gourd (25.8 t/ha) was obtained from treatment T_0 (Open field referred as control) (Fig. 1). The second highest yield of sweet gourd (23.7 t/ha) yield was recorded at treatment T_4 (> 1.5 m distance from the tree) and the lowest (16.2 t/ha) was observed

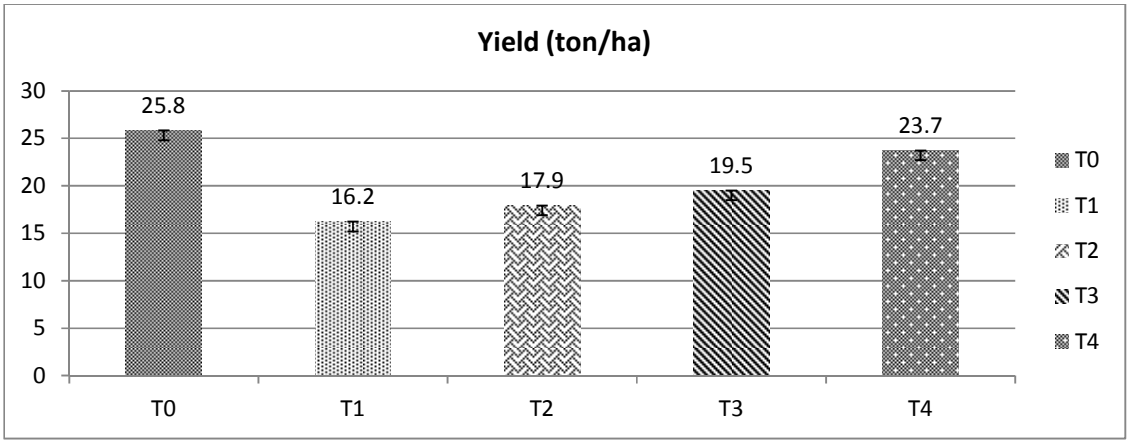

Fig. 1. Yield of sweet gourd along with mango tree

under the close contact of tree which referred as T_1 (0.0-0.5 m distance from tree). Yield performance of sweet gourd was better under sole cropping condition When compared with tree-crop base condition may be due to the absence of competition for natural resources. Reddy et al. [13] note that the yield of sweet gourd decreased by increasing shade level.

3.2 Morphological Parameters of Mango with and Without Sweet Gourd

The growth characteristics of mango such as, no of branch plant^{-1}, average no of fruit branch^{-1}, no of fruit plant^{-1}, average fruit length, average fruit diameter and average fruit weight was significantly influenced by sweet gourd during the cropping season (Table 2).

3.2.1 Number of branch plant^{-1}

The average no. of branch plant^{-1} was 17.1 and 20 in association with sweet gourd combination and without sweet gourd combination respectively (Table 2). This result indicates growth of mango tree component was lower along with sweet gourd; this may be due to competition for different growth parameter like light, water and nutrients. Similar result also observed by [14]. The highest tree girth was reported by [12,15] in agroforestry combination.

3.2.2 Average number of fruit branch^{-1}

The average no. of fruit branch^{-1} was 3.3 and 3.7 in association with sweet gourd combination and without sweet gourd combination respectively (Table 2). The above result indicates that the growth of mango tree components was lower along with sweet gourd, this may due to competition for different growth parameter like, light, water and nutrients. Similar type of result was reported by [14]. Similar type of result was reported by [16].

3.2.3 Number of fruit plant^{-1}

The no. of fruit plant^{-1} was 56.4 and 74.4 in association with sweet gourd combination and without sweet gourd combination respectively (Table 2). This result indicates growth of mango tree components was lower along with sweet gourd, this may due to competition for different growth parameter like light, water and nutrients. Similar result also observed by [14].

Table 2. Morphological parameters of mango with and without sweet gourd combination

	Tree	No. of bunch plant^{-1}	Av. no. of fruit bunch^{-1}	No. of fruit plant^{-1}	Av. fruit length (cm)	Av. fruit diameter (cm)	Av. fruit weight (g)
With sweet gourd	1	17	4.0	68.0	9.6	15.3	127.6
	2	16	3.5	56.0	9.1	16.0	131.0
	3	19	3.0	57.0	9.3	15.6	126.0
	4	16	3.4	54.4	9.6	14.9	127.8
	5	15	4.0	60.0	10.0	15.6	127.4
	6	20	3.0	60.0	10.2	16.0	130.9
	7	18	3.4	61.2	8.6	15.1	127.8
	8	17	2.5	42.5	8.6	15.4	124.2
	9	15	3.5	52.5	9.1	15.6	126.5
	10	18	2.7	48.6	9.3	15.1	126.0
	Average	17.1	3.3	56.4	9.3	15.5	127.5
Without sweet gourd	1	20	4.5	90.0	10.5	17.2	141.8
	2	18	3.0	54.0	10.0	18.0	145.5
	3	22	3.5	77.0	10.2	17.5	140.0
	4	17	3.0	51.0	10.5	16.7	142.0
	5	23	4.2	96.6	11.0	17.5	141.5
	6	22	4.0	88.0	11.2	18.0	145.4
	7	19	4.0	76.0	9.5	17.0	142.0
	8	20	3.0	60.0	9.5	17.3	138.0
	9	21	3.0	63.0	10.0	17.5	140.5
	10	18	5.0	90.0	10.2	17.0	140.0
	Average	20	3.7	74.4	10.3	17.4	141.7

Note: Means in column followed significantly different by DMRT at $p \leq 0.01$

3.2.4 Average fruit length (cm)

The average fruit lengths of mango were 9.3 and 10.3 in association with sweet gourd combination and without sweet gourd combination respectively (Table 2). This result indicates that the growth of mango tree components was when grown with sweet gourd, this may be due to competition for different growth parameter like light, water and nutrients.

3.2.5 Average fruit diameter (cm)

The growth characteristics of mango such as average fruit diameter were significantly influenced by sweet gourd during the cropping season. Average fruit diameters of mango were 15.5 and 17.4 in association with sweet gourd combination and without sweet gourd combination respectively (Table 2). This result indicates growth of mango tree components was lower in the presence of sweet gourd, this may due to competition for different growth parameter like, light, water and nutrients.

3.2.6 Average fruit weight (g)

The growth characteristic of mango such as average fruit weight was significantly influenced by sweet gourd during the cropping season. Average fruit weights of mango were 127.5 and 141.7 in association with sweet gourd combination and without sweet gourd combination respectively (Table 2). This result indicates growth of mango tree components was lower along with sweet gourd, this may due to competition for different growth parameter like, light, water and nutrients.

3.2.7 Yield of mango (kg/plant)

The best fruit yield of mango (10.5 kg/plant) was recorded in without sweet gourd association (Fig. 2). In association with sweet gourd the fruit yield of mango was recorded 7.2 kg/plant. In control condition i.e. without sweet gourd mango yield were higher compare to mixed combination with sweet gourd.

3.2.8 Yield of mango (t/ha)

The best fruit yield of mango (8.6 t/ ha) was recorded in without sweet gourd association (Fig. 3). In association with sweet gourd the fruit yield of mango was recorded (5.9 t/ha). In control condition i.e. without sweet gourd mango yield were higher compare mixed combination with

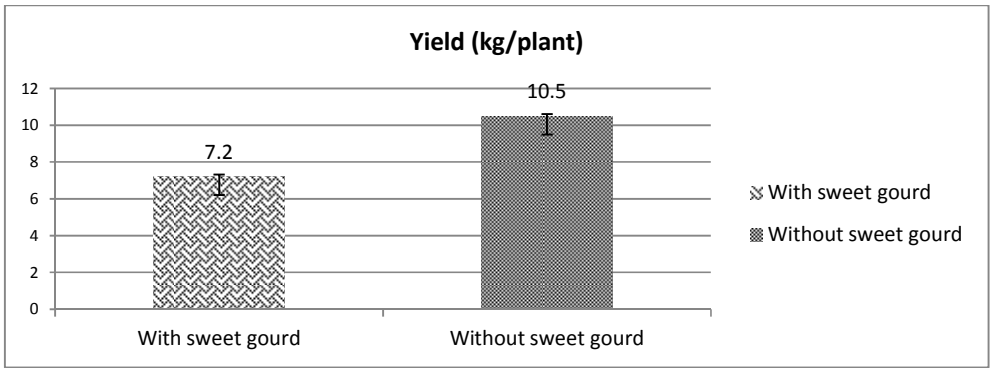

Fig. 2. Yield (kg/plant) of mango with and without sweet gourd

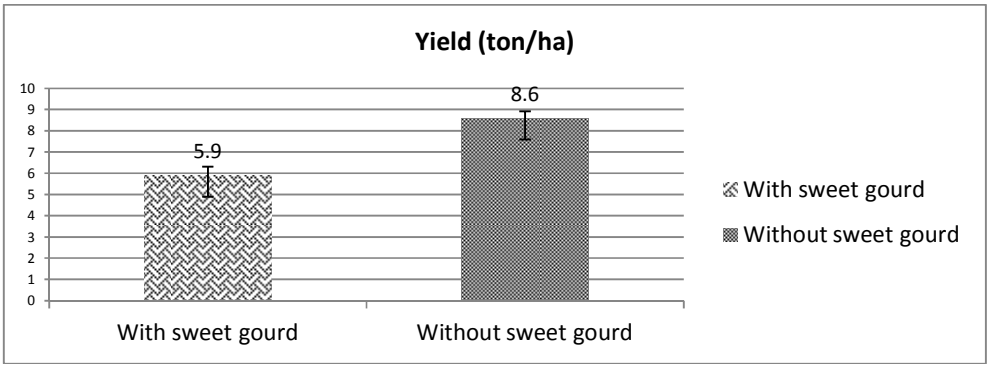

Fig. 3. Yield (t/ha) of mango with and without sweet gourd

sweet gourd. This result indicates that the fruit yield of mango were higher without sweet gourd combination.

4. CONCLUSION

From the study, it is observed that, yield of sweet gourd as a vegetable under open field condition give the best growth performance. However, when associated with mango tree as an agroforestry system. Large spacing gives the best production of sweet gourd. The short planting distance showed less production due to competition among nutrient, water and other growth factors in agroforestry system.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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